REL SOUTHWEST Regional Educational Laboratory Southwest

REL Southwest Ask A REL Response

July 2020

Question:

What approaches have been most successful for training and supporting teachers with implementation of Next Generation Science Standards?

Response:

Thank you for the question you submitted to our REL Reference Desk. We have prepared the following memo with research references to help answer your question. For each reference, we provide an abstract, excerpt, or summary written by the study's author or publisher. Following an established Regional Educational Laboratory (REL) Southwest research protocol, we conducted a search for research reports as well as descriptive study articles on the most successful approaches for training and supporting teachers with implementation of Next Generation Science Standards.

We have not evaluated the quality of references and the resources provided in this response. We offer them only for your reference. Also, we searched the references in the response from the most commonly used resources of research, but they are not comprehensive, and other relevant references and resources may exist. References provided are listed in alphabetical order, not necessarily in order of relevance. We do not include sources that are not freely available to the requestor.

Research References

Guzey, S. S., Tank, K., Wang, H.-H., Roehrig, G., & Moore, T. (2014). A high-quality professional development for teachers of grades 3-6 for implementing engineering into classrooms. *School Science and Mathematics, 114*(3), 139–149. https://eric.ed.gov/?id=EJ1028793. Retrieved from https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1006&context=enepubs

From the ERIC abstract: "With the increasing emphasis on integrating engineering into K-12 classrooms to help meet the needs of our complex and multidisciplinary society, there is an urgent need to investigate teachers' engineering-focused professional development experiences as they relate to teacher learning, implementation, and student achievement. This study addresses this need by examining the effects of a professional development program focused on engineering integration, and how teachers chose to implement engineering in their classrooms as a result of the professional development.

198 teachers in grades 3-6 from 43 schools in 17 districts participated in a yearlong professional development program designed to help integrate the new state science standards, with a focus on engineering, into their teaching. Posters including lesson plans and student artifacts were used to assess teachers' engineering practices and the implementation in their classrooms. Results indicated that the majority of the teachers who participated in the professional development were able to effectively implement engineering design lessons in their classrooms suggesting that the teachers' success in implementing engineering lessons in their classroom was closely related to the structure of the professional development program."

Kang, E. J. S., McCarthy, M. J., & Donovan, C. (2019). Elementary teachers' enactment of the NGSS science and engineering practices. *Journal of Science Teacher Education, 30*(7), 788–814. https://eric.ed.gov/?id=EJ1230141. Retrieved from https://www.researchgate.net/publication/334178160

From the ERIC abstract: "This paper reports findings from a two-year investigation on the impact of a professional development (PD) program on second grade teachers' science teaching practice, particularly of the Next Generation Science Standards Science and Engineering Practices (NGSS SEPs). The aims of this study were three-fold: 1) identify which SEPs teachers enacted during classroom instruction at the start and end of the PD; 2) explore the ways in which the SEPs were enacted; and 3) explore trends in self-efficacy and confidence of teaching the NGSS SEPs at mid and end points of the PD compared to the start of the program. Analysis of classroom observations revealed that, at time 2 (end of PD), teachers tended to incorporate more of the practices into instruction, with the greatest increase experienced by SEP 7 Engaging in Argumentation. Students also played a more active role in enacting each practice. Classroom observations revealed that, at both time 1 and time 2, teachers successfully utilized both general and SEP-specific scaffolds to support student enactment. Moreover, rather than teaching each practice in isolation, teachers integrated practices together to reach their lesson objective. While students were able to successfully enact most of the practices, they tended to struggle with specific aspects of argumentation and explanation. Finally, teachers experienced significant growth in self-efficacy and confidence of teaching the SEPs as well as in actual classroom practice."

Krajcik, J., Codere, S., Dahsah, C., Bayer, R., & Mun, K. (2014). Planning instruction to meet the intent of the Next Generation Science Standards. *Journal of Science Teacher Education, 25*(2), 157–175. https://eric.ed.gov/?id=EJ1039014. Retrieved from https://www.tandfonline.com/doi/pdf/10.1007/s10972-014-9383-2

From the ERIC abstract: "The National Research Council's 'Framework for K-12 Science Education' and the Next Generation Science Standards ('NGSS Lead States in Next Generation Science Standards: For states, by states.' The National Academies Press, Washington, 2013) move teaching away from covering many isolated facts to a focus on a smaller number of disciplinary core ideas (DCIs) and crosscutting concepts that can be used to explain phenomena and solve problems by engaging in science and engineering practices. The NGSS present standards as knowledge-in-use by expressing them as performance expectations (PEs) that integrate all three dimensions from the 'Framework

for K-12 Science Education.' This integration of core ideas, practices, and crosscutting concepts is referred to as three-dimensional learning (NRC in 'Division of Behavioral and Social Sciences and Education.' The National Academies Press, Washington, 2014). PEs state what students can be assessed on at the end of grade level for K-5 and at the end of grade band for 6-8 and 9-12. PEs do not specify how instruction should be developed nor do they serve as objectives for individual lessons. To support students in developing proficiency in the PEs, the elements of the DCIs will need to be blended with various practices and crosscutting concepts. In this paper, we examine how to design instruction to support students in meeting a cluster or 'bundle' of PEs and how to blend the three dimensions to develop lesson level PEs that can be used for guiding instruction. We provide a ten-step process and an example of that process that teachers and curriculum designers can use to design lessons that meet the intent of the Next Generation of Science Standards."

Lotan, R. A., & Burns, D. (2019). *The Instructional Leadership Corps: Teachers leading sustainable professional learning in their communities*. Palo Alto, CA: Learning Policy Institute. https://eric.ed.gov/?id=ED603437

From the ERIC abstract: "The teaching profession requires continuous learning, and in 2014, a new model of professional learning was introduced in California by the Instructional Leadership Corps (ILC), a group of expert teachers who organize local professional development to spark iterative changes in practice. In the four years following its launch, the ILC connected with more than 100,000 educators through an approach that supports school-based learning and develops teacher leaders as well as instructional leadership among administrators. It has begun to transform California's statewide capacity to implement the Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS). These new standards are moving instruction away from a transmission curriculum that often featured scripted lessons and multiple choice tests toward higher-order critical thinking skills acquired through student engagement in inquiry and problem-solving—a shift that requires major transformations in how teachers teach and students learn. In this study, the authors sought to discover how ILC teams in different settings gained traction and began to transform professional learning opportunities in their communities and regions, often addressing long-standing problems of practice and inequities in children's access to high-quality instruction. Given that practitioner-led professional learning has often failed to gain a toehold in districts in which teacher leaders are appointed but not integrated into the work of the schools, they wanted to understand what has enabled the work of the ILC to grow and become rooted in various communities. They examined the strategies used by ILC leaders both in conducting professional development and in connecting their work to the broader efforts of their districts and counties. They also examined the perceived impacts on practice for teacher participants. The authors studied the work of ILC teams at four very different sites: (1) Madera Unified School District; (2) East Side Alliance; (3) Consejo Valley Unified School District; and (4) North Orange County."

McGee, S., & Nutakki, N. (2017). The impact of adapting a general professional development framework to the constraints of in-service professional development on the Next

Generation Science Standards in urban settings. *Journal of Urban Learning, Teaching, and Research, 13*, 73–89. https://eric.ed.gov/?id=EJ1149889

From the ERIC abstract: "Urban school districts face a dilemma in providing professional development support for teachers in transition to the Next Generation Science Standards (NGSS). Districts need to maximize the quality and amount of professional development within practical funding constraints. In this paper, we discuss preliminary results from a researcher-practitioner partnership between Northwestern University and the Chicago Public Schools. We explore a model for quarterly NGSS professional development for urban middle school science teachers that spans three years. The workshop inquiry experiences are aligned to areas of research excellence at Northwestern. Teachers in twenty-three of the schools responded to a survey on the impact of formal and informal learning experiences on changes in teaching practice. We also analyzed the growth in student-rated inquiry-based science teaching practices. The results indicate that the professional development program had a significant direct impact on teaching practices as well as indirect impact on the teaching practices of other teachers at the school."

Penuel, W. R., Harris, C. J., & DeBarger, A. H. (2015). Implementing the next generation science standards. *Phi Delta Kappan*, *96*(6), 45-49. https://eric.ed.gov/?id=EJ1058958. Retrieved from https://kappanonline.org/implementing-next-generation-science-standards-penuel-harris-debarger/

From the ERIC abstract: "The Next Generation Science Standards embody a new vision for science education grounded in the idea that science is both a body of knowledge and a set of linked practices for developing knowledge. The authors describe strategies that they suggest school and district leaders consider when designing strategies to support NGSS implementation."

Richman, L. J., Haines, S., & Fello, S. (2019). Collaborative professional development focused on promoting effective implementation of the Next Generation Science Standards. *Science Education International, 30*(3), 200–208. https://eric.ed.gov/?id=EJ1230177

From the ERIC abstract: "The purpose of this study was to examine the design, implementation, and initial outcomes of a collaborative professional development program intended to prepare middle and high school educators to implement effectively the Next Generation Science Standards (NGSS) in classrooms with diverse learners. The professional development program discussed herein was designed by a university in partnership with a local school district and incorporated key principles of effective professional development associated with promoting substantial changes in teacher knowledge and practice recommended in the research literature (Darling-Hammond et al., 2009; Guskey, 2002; Reiser, 2013). Topics covered in the professional development included NGSS practices and crosscutting concepts, Universal Design for Learning, and disciplinary literacy. Results suggest that the impact of this professional development program was positive. Feedback from participants was favorable and will be shared as well."

Utley, J., Ivey, T., Hammack, R., & High, K. (2019). Enhancing engineering education in the elementary school. *School Science and Mathematics, 119*(4), 203–212. https://eric.ed.gov/?id=EJ1212315. Retrieved from https://scholarworks.montana.edu/xmlui/bitstream/handle/1/15490/Hammack_SSM_2019_FINAL.pdf

From the ERIC abstract: "The Next Generation Science Standards emphasizes the inclusion of engineering practices throughout the K-12 science curriculum. Therefore, elementary educators need to be knowledgeable about engineering and engineering careers so that they can expose their students to engineering. The purpose of this study was to examine the effect of engineering professional development on in-service elementary teachers': (a) knowledge and perceptions regarding engineering, and (b) self-efficacy of teaching engineering. This quantitative study revealed that even one professional development opportunity can help to alleviate some misconceptions about the work of engineers and what constitutes technology, as well as increase teachers' confidence to teach engineering concepts."

Additional Organizations to Consult

BSCS – https://bscs.org/

From the website: The BSCS mission is "transforming science education through research-driven innovation."

"BSCS has filled classrooms around the country with research-driven biology textbooks, pioneered effective teaching approaches, developed new education leaders, and conducted studies that will continue to alter the course of our science education system. Most importantly, we have championed the cause for meaningful, inquiry-based science learning."

REL Southwest Note: The BSCS website includes resources to support implementation of the NGSS, including the following:

- *Five Tools and Processes for Translating the NGSS* – https://bscs.org/resources/educator-resource-center/five-tools-and-processes-for-translating-the-ngss/
- *Guidelines for Assessing Instructional Materials that Exemplify the NGSS* – https://bscs.org/resources/reports/guidelines-for-assessing-instructional-materials-that-exemplify-the-ngss/

Community for Advancing Discovery Research in Education (CADRE) – https://cadrek12.org/

From the website: "CADRE is a network for STEM education researchers funded by the National Science Foundation's Discovery Research PreK-12 (DRK-12) program. Through in-person meetings, a web site, common interest groups, newsletters, and more, CADRE connects these researchers who are endeavoring to improve education in science, technology, engineering and mathematics in, and outside of, our schools.

CADRE helps DRK-12 researchers share their methods, findings, results, and products inside the research and development community and with the greater public so that we are:

- better informed about the work that is being done,
- continually building on what we have collectively learned,
- working with our schools, communities, and policy-makers to make our findings and products accessible and usable, and
- progressively able to address new and more challenging issues—including those issues that extend beyond the limits of what any singular research project can impact.

Together, we can make a larger impact on policy, research and education."

REL Southwest Note: "CADRE's Spotlights (https://cadrek12.org/spotlights-on-stem-topics) explore important themes in K-12 STEM education research and development by highlighting DRK-12 project contributions, community perspectives, and important resources."

National Science Teaching Association (NSTA) NGSS Hub – https://ngss.nsta.org/

From the website: "Founded in 1944, the National Science Teaching Association (NSTA) is…the largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all."

REL Southwest Note: This website compiles online resources in the following categories:

- About NGSS
- Curriculum Planning
- Classroom Resources
- Professional Learning
- NGSS Blog

Next Generation Science Standards – https://www.nextgenscience.org/

From the website: "The Next Generation Science Standards (NGSS) are K–12 science content standards. Standards set the expectations for what students should know and be able to do. The NGSS were developed by states to improve science education for all students.

A goal for developing the NGSS was to create a set of research-based, up-to-date K–12 science standards. These standards give local educators the flexibility to design classroom learning experiences that stimulate students' interests in science and prepares them for college, careers, and citizenship...

The NGSS call for a three-dimensional approach to K–12 science instruction. This represents a significant transition from previous state standards. That's why effective implementation demands a great deal of collaboration and patience among states, districts, schools, teachers, and students.

Thoughtful and coordinated approaches to implementation will enable educators to inspire future generations of scientifically literate students. *That is the vision of the NGSS*. This website provides a range of high-quality resources that empower educators, administrators, parents, and the general public to help bring this vision to life."

REL Southwest Note: This website compiles strategies for NGSS implementation in the following areas:

- Classroom Sample Tasks
- Rubric for Lessons and Units
- Middle and High School Course Mapping
- Evidence Statements

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- [("Next Generation Science Standards" OR "NGSS") AND "support for implementation")]
- [("Next Generation Science Standards" OR "NGSS") AND "professional development")]
- instructional support ("Next Generation Science Standards" OR "NGSS")
- teacher training ("Next Generation Science Standards" OR "NGSS")
- tutorials ("Next Generation Science Standards" OR "NGSS")
- [("Next Generation Science Standards" OR "NGSS") AND ("disciplinary core ideas" OR "science and engineering practices" OR "crosscutting concepts")]
- [("Next Generation Science Standards" OR "NGSS") AND ("assessments")]
- [("Next Generation Science Standards" OR "NGSS") AND ("curriculum")]
- [("science and engineering practices") AND ("support for implementation")]
- [("science and engineering practices") AND ("professional development")]
- instructional support ("science and engineering practices")
- teacher training ("science and engineering practices")
- tutorials ("science and engineering practices")
- [("disciplinary core ideas") AND ("support implementation")]
- [("disciplinary core ideas") AND ("professional development")]
- instructional support ("disciplinary core ideas")
- teacher training ("disciplinary core ideas")

- tutorials ("disciplinary core ideas")
- [("crosscutting concepts") AND ("support implementation")]
- [("crosscutting concepts") AND ("professional development")]
- instructional support ("crosscutting concepts")
- teacher training ("crosscutting concepts")
- tutorials ("crosscutting concepts")

Databases and Resources

We searched ERIC for relevant, peer-reviewed research references. ERIC is a free online library of more than 1.8 million citations of education research sponsored by the Institute of Education Sciences (IES). Additionally, we searched the What Works Clearinghouse.

Reference Search and Selection Criteria

When we were searching and reviewing resources, we considered the following criteria:

- *Date of the publication:* References and resources published from 2005 to present, were included in the search and review.
- *Search priorities of reference sources:* Search priority is given to study reports, briefs, and other documents that are published and/or reviewed by IES and other federal or federally funded organizations, academic databases, including ERIC, EBSCO databases, JSTOR database, PsychInfo, PsychArticle, and Google Scholar.
- *Methodology:* The following methodological priorities/considerations were given in the review and selection of the references: (a) study types—randomized control trials, quasi-experiments, correlational studies, descriptive data analyses, literature reviews, mixed methods analyses, and so forth; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected, and so forth), study duration, and so forth; and (c) limitations, generalizability of the findings and conclusions, and so forth.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by stakeholders in the Southwest Region (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas), which is served by the Regional Educational Laboratory (REL) Southwest at AIR. This memorandum was prepared by REL Southwest under a contract with the U.S. Department of Education's Institute of Education Sciences (IES), Contract ED-IES-91990018C0002, administered by AIR. Its content does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.